

ECE 345 / ME 380: Introduction to Control Systems

State-space solutions

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Description	Time-domain	Frequency domain
State transition matrix	$\phi(t) = e^{At}$	$\Phi(s) = (sI - A)^{-1}$
State response	$x(t) = \left(\begin{array}{c} \\ \end{array} \right) x_0 + \int_0^t e^{A(t-\tau)} Bu(\tau) d\tau$	$X(s) = (sI - A)^{-1} x_0 + (sI - A)^{-1} BU(s)$
Output response	$y(t) = Ce^{At} x_0 + C \int_0^t e^{A(t-\tau)} Bu(\tau) d\tau + Du(t)$	$Y(s) = C(sI - A)^{-1} x_0 + \left(\begin{array}{c} \\ \end{array} \right) U(s)$
Natural response	$x(t) = \quad , \text{ or } \\ y(t) =$	$X(s) = (sI - A)^{-1} x_0, \text{ or } \\ Y(s) = C(sI - A)^{-1} x_0$
Forced response	$x(t) = \int_0^t e^{A(t-\tau)} Bu(\tau) d\tau, \text{ or } \\ y(t) = C \int_0^t e^{A(t-\tau)} Bu(\tau) d\tau$	$X(s) = \quad , \text{ or } \\ Y(s) =$